Module 18
Principles of Load Charts

75.4	22,000	78.6	19,000
73.5	20,000	77.1	17,000
69.4	16,000	73.9	14,500
64.2	13,000	69.9	12,000
58.7	10,000	65.7	9,500
52.9	8,000	61.4	8,000
47.1	6,650	57.3	6,750
39.8	5,300	52.6	5,500

Learning Objectives

By the end of this section, you will:

1. Know what information is provided on load charts.
2. Know why using signs of tipping is not the correct way to determine capacity.
3. Know the key factors that affect crane stability and structural integrity.
4. Compare strength capacity to stability capacity on different types of load charts.

The operator is responsible for knowing how to properly use a load chart to ensure safe operations.

The load chart must be correctly interpreted so the crane can be operated within designed limits to ensure the safety and efficiency of personnel and equipment on the job site.

There is no room for guesswork in craning operations.

The operator is responsible for ensuring that all the information required for making a safe lift is available prior to operating the craning equipment. The operator can be held responsible for any accident that may have resulted from operating the equipment unsafely. This includes not having the right information to determine whether or not the lift was safe. Lifts involve a very expensive piece of equipment being lifted into place by a very expensive crane.

Guesswork can have disastrous results. When hoisting it can result in equipment damage from breaking parts or the crane may tip over. Or worse, it may result in personal injury or death. Consult the supervisor if loads seem to be especially difficult or close to the limit.

Each crane has a load chart that relates specifically to that crane.

Capacity calculations should only be made with the load chart that corresponds with the serial number for the specific crane for which the lift calculation is made.

There are guidelines designed to assist the operator through every phase of a lift.

The load chart for each crane spells out the limitations and performance expectations for that crane under near perfect conditions.

Operate within limits

Consider all factors

Safe and productive operations can be ensured by correctly applying guidelines and then operating within the limits of the crane. All cranes have limitations and operators seldom experience perfect operating conditions, therefore it is critical to consider all factors.

Crane capacities are based on four factors: machine weight, stability, strength of the components and environmental conditions.

Signs of tipping should never be used to determine the limits of the crane's capacity. Always use the load chart to determine capacity.

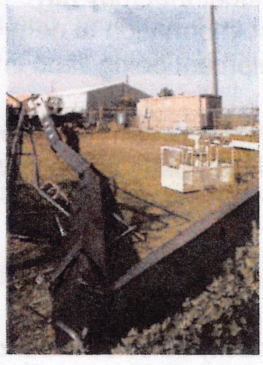
OSHA® 1926.1417 (o)(1) & (2)

The load chart should always be used to determine the capacity for every lift. Load capacity is calculated by taking each variance and condition into account. Signs of tipping reflect a hazardous condition because tipping can occur rapidly and may not be recoverable. Structural failure can easily occur before any signs of tipping appear.

A crane should not be lifting in a position where the load chart shows no capacity for a particular boom angle, length or quadrant of operation.

The weight of boom and empty load block may be sufficient to cause damage or tipping.

Case Study



This crane in Blufton, Indiana had a good deal of its 190 feet of total boom and jib out in order to remove radio equipment from the tower when the accident occurred. There were no reports of any injuries from the accident which happened in the grounds of the school. The boom came down on a security fence surrounding the tower and a portable baseball batting cage. Porter County Sheriff's deputies and the Washington Township Volunteer Fire Department responded to the scene.
http://www.vertikal.net/en/news/story/6303/

Load Chart Formats

Every word and symbol in the chart is relevant to proper interpretation of the load chart and must be understood.

MANITOWOC ENGINEERING CO.
(A division of The Manitowoc Company, Inc.) Manitowoc, Wisconsin 54220

LIFTCRANE CAPACITIES

MEETS ANSI B30.5 REQUIREMENTS EXCEPT WHERE NOTED WITH B

4100W

4100W SERIES-1 CRAWLER

BOOM NO. 22C WITH OPEN THROAT TOP
26'6" CRAWLERS — 122,400 LB. COUNTERWEIGHT

LIFTING CAPACITIES: Capacities for various boom lengths and operating radii may be based on per cent of tipping, strength of structural components, operating speeds and other factors. Capacities are for freely suspended loads and do not exceed 75% of a static tipping load. Capacities based on structural competence are shown by shaded areas.

Capacities indicated by "B" represent boom positions which without load, provide less than required ANSI B30.5 backward stability.

Capacities are shown in pounds. Deduct 1200 pounds from capacities listed when single sheave upper boom point is attached and 1500 pounds when two sheave upper boom point is attached. To comply with B30.5 requirements, upper boom point cannot be used on the 260 ft. boom. Weight of jib (see chart A), all load blocks, hooks, weight ball, slings, hoist lines beneath boom and jib point sheaves, etc., is considered part of the main boom load. Boom is not to be lowered beyond radii where combined weights are greater than rated capacity. Where no capacity is shown, operation is not intended or approved.

OPERATING CONDITIONS: Machine to operate in a level position on a firm surface with gantry in working position and be rigged in accordance with and under conditions referred to in rigging drawing No. 190693 and load line specification chart No. 5345.

Crane operator judgment must be used to allow for dynamic load effects of swinging, hoisting or lowering, travel, as well as adverse operating conditions & physical machine depreciation.

OPERATING RADIUS: Operating radius is the horizontal distance from the axis of rotation to the center of vertical hoist line of load block with the load freely suspended. Add 14" to boom point radius for radius of sheave when using single part hoist line.

Boom angle is the angle between horizontal and centerline of boom butt and inserts and is an indication of operating radius. In all cases, operating radius shall govern capacity.

BOOM POINT ELEVATION: Boom point elevation, in feet, is the vertical distance from ground level to centerline of boom point shaft.

MACHINE EQUIPMENT: Machine equipped with 26'6" extendible crawlers, 48" treads, 17' retractable gantry, 12 part boom hoist reeving, four 1⅛" boom pendants, 1st ctwt. 41,900 lbs., 2nd ctwt. 41,500 lbs., 3rd ctwt. 39,000 lbs. Total counterweight 122,400 pounds.

HOIST REEVING FOR MAIN LOAD BLOCK						
No. Parts of Line	1	2	3	4	5	6
Max. Load — Lbs.	32,500	65,000	97,500	130,000	162,500	195,000
No. Parts of Line	7	8	9	10	11	12
Max. Load — Lbs.	227,500	260,000	292,500	325,000	357,500	400,000

LOAD AND WHIP LINE SPECIFICATIONS
LOAD LINE: 1-1/8" — 6x31 Warrington-Seale, Extra Improved Plow Steel, Regular Lay, IWRC. Minimum Breaking Strength 65 Ton. (Approx. Weight Per Ft. in Lbs. 2.34)
WHIP LINE: 1-1/8" — 6x31 Warrington-Seale, Improved Plow Steel, Regular Lay, IWRC. Minimum Breaking Strength 56.5 Ton. Maximum Load — 28,300 Lbs. Per Line. (Approx. Weight Per Ft. in Lbs. 2.34)

MAXIMUM BOOM AND JIB LENGTHS LIFTED UNASSISTED			
OVER FRONT OF BLOCKED CRAWLERS		OVER SIDE OF EXTENDED CRAWLERS	
Boom Length	Jib No. 123	Boom Length	Jib No. 123
260'	——	230'	——
250'	——	220'	30'
240'	40'	210'	60'
230'	60'		
OVER SIDE OF RETRACTED CRAWLERS		(A) DEDUCT FROM CAPACITIES WHEN JIB IS ATTACHED	
Boom Length	Jib No. 123	Jib Length	Jib No. 123
220'	——	30'	2,000 Lb
210'	——	40'	3,600 Lb
200'	50'	50'	4,200 Lb
190'	60'	60'	4,900 Lb
Load block, hook and weight ball on ground at start.			

For jib capacities, consult jib chart.

Boom	Oper.	Rad.	Boom	Capacity	Capacity	Boom	Oper.	Rad.	Boom	Capacity	Capacity	Boom	Oper.	Rad.	Boom	Capacity	Capacity

Load charts provide load rating capacities in relation to:

1. **The crane components strength.**
2. **The crane stability.**

Strength Capacity

Strength capacity is based on the structural strength of materials, boom, jib, etc.

Material strength and structural limitations are the factors of crane leverage that contribute to equipment damage when capacities are exceeded. Several parts of the crane could be damaged, such as the wire rope, boom, gantry, outriggers, or chassis.

Case Study

May 10, 2012 A 100 ton crane boom buckled while lifting bridge beams in Northern Norway. The crane was working from a massive barge, installing a new bridge when the incident occurred. No one was injured. According to the plant manager employed by the contractor, Reinertsen, the crane's boom was almost fully extended to between 130 and 160 feet when the second section suddenly buckled. Although it is not clear we also understand that the final section also broke away – possibly as it landed? An investigation is underway with talk of overloading, fatigue, side loadings or other causes.

http://www.vertikal.net/en/news/story/14810/

Structural failure may not mean immediate collapse or breakage. Overloaded cranes may fail on future lifts. Typical damages include:

- Pendant breaks.
- Jib failure.
- Hoist line failure.
- Boom bending or collapse.
- Upperworks separate.
- Track or pad failure.
- Gantry collapse.
- Boom cylinder failure.
- Carrier frame bending.
- Outrigger beam or pad failure.
- Turret failure.

Stability Capacity

Stability capacity is based on the stability of the crane or the weight necessary to tip the crane over.

Case Study

A crane crashed into a house in Shoreview, Minnesota near St. Paul after it tipped while lifting a large hot tub/pool into the back yard. The crane, a four axle Grove truck crane was properly set up with outrigger mats in place and all outriggers fully extended. Fortunately no one was hurt and the damage was surprisingly light with a garage roof and a chimney badly damaged. The crane's boom is also likely to be a casualty. The company quickly called in two other mobile cranes and completed the recovery and clean up by nightfall. The homeowner was reportedly told that the accident was caused by 'A computer malfunction' – it looks of course like a classic overload, possibly brought on by some sort of input error on the rated load indicator?
http://www.vertikal.net/en/news/story/12542/

Determining Capacities

The type and number of charts available for a crane vary greatly depending on the type of crane and the crane manufacturer.

BOOM CAPACITY CRAWLERS RETRACTED POUNDS	BOOM CAPACITY CRAWLERS EXTENDED POUNDS
	405,400*
	386,000*
	366,700*
	349,100*
	318,300*
	292,200*
	270,000*
	250,600*
	233,700*
	218,800*
	199,800
	183,400
	169,300
	157,000
	146,300
116,200	136,900
109,300	128,500
103,100	120,900
97,400	114,200

MANITOWOC 888-II

28 ft. - 70 ft. BOOM

GGERS FULLY EXTENDED - 360

Boom Length in Feet

40	46	52	58
,000	29,800	27,800	
,500	27,500	27,000	25,750
,000	21,000	20,750	20,500
,500	15,500	15,500	15,500
,700	11,700	11,700	11,700
	8,650	8,650	8,650
	6,650	6,650	6,650
		5,250	5,250
			4,250

A6-829-000195

GROVE RT59S

BOOM RATED LOADS WITHOUT JIB

LOADED BOOM ANGLE (deg)	B 61 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	C 76 ft BOOM (lb)	LC B A (
77.4	24,000			
75.4	22,000	78.6	19,000	
73.5	20,000	77.1	17,000	
69.4	16,000	73.9	14,500	
64.2	13,000	69.9	12,000	
58.7	10,000	65.7	9,500	
52.9	8,000	61.4	8,000	
47.1	6,650	57.3	6,750	
39.8	5,300	52.6	5,500	
31.5	4,300	47.5	4,550	
20.3	3,500	42	3,700	
		35.7	2,950	
		28.3	2,300	
		18.3	1,800	

National Crane Series 900H

The difference between strength factors and stability factors on a load chart is noted by a heavy line, shaded area, or asterisks.

Example: structural strength is denoted above a heavy line.

RATED LIFTING CAPACITIES IN POUNDS

28 ft. - 70 ft. BOOM

Radius in Feet	OUTRIGGERS FULLY EXTENDED - 360° Boom Length in Feet								* ON RUBBER	
	28	34	40	46	52	58	64	70	Over Front	Over Side
12	30,000	30,000	30,000	29,800	27,800				24,500	14,800
15	27,500	27,500	27,500	27,500	27,000	25,750	23,700		16,600	9,800
20	21,250	21,250	21,000	21,000	20,750	20,500	20,400	20,250	10,300	5,450
25		15,500	15,500	15,500	15,500	15,500	15,000	15,000	6,650	3,660
30			11,700	11,700	11,700	11,700	11,700	11,700	4,850	2,300
35				8,650	8,650	8,650	8,650	8,650	3,380	1,330
40				6,650	6,650	6,650	6,650	6,650	2,680	470
45					5,250	5,250	5,250	5,250	1,525	
50						4,250	4,250	4,250	950	
55							3,460	3,460	635	
60							2,760	2,760		
65								2,180		
66.5					A6-829-000195			1,970	A6-829-000197	

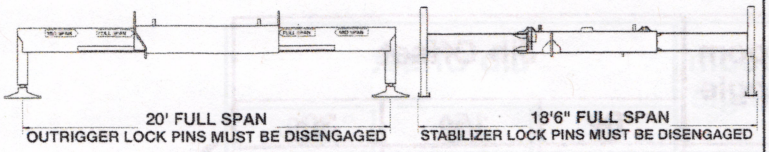
Capacities appearing above bold line are based upon structural strength and not on machine stability.
Capacities do not exceed 85% of tipping loads.

* Chart based on 16.00 x 24 tires and 80 PSI

Load chart from GROVE RT59S

Example: structural strength denoted by a shaded area.

9105H
105 ft BOOM
25 – 44 ft JIB
FULL SPAN
OUTRIGGER
AND
STABILIZER



32 ft – 105 ft BOOM RATED LOADS WITHOUT JIB

LOADED RADIUS (ft)	LOADED BOOM ANGLE (deg)	32 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	A 46 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	B 61 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	C 76 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	D 90 ft BOOM (lb)	LOADED BOOM ANGLE (deg)	105 ft BOOM (lb)
5	77.2	54,000										
8	71.5	40,000	77.6	29,000								
10	67.6	34,000	75	27,000								
12	63.5	30,000	72.4	24,950	77.4	24,000						
14	59.4	24,000	69.7	22,850	75.4	22,000	78.6	19,000				
16	55	22,000	67	20,450	73.5	20,000	77.1	17,000				
20	45.4	16,500	61.3	16,950	69.4	16,000	73.9	14,500	77.5	13,000		
25	30.2	12,000	53.8	12,900	64.2	13,000	69.9	12,000	74.3	11,000	77.5	10,000
30			45.4	10,000	58.7	10,000	65.7	9,500	70.8	8,750	74.7	9,000
35			35.5	7,750	52.9	8,000	61.4	8,000	67.6	7,500	72.1	8,500
40			23.3	6,300	47.1	6,650	57.3	6,750	64	6,500	69.2	7,100

Load chart from National Crane Series 900H

Example: structural strength denoted by an asterisk.

BOOM LGTH. FEET	OPER. RAD. FEET	BOOM ANG. DEG.	BOOM POINT ELEV. FEET	BOOM CAPACITY CRAWLERS RETRACTED POUNDS	BOOM CAPACITY CRAWLERS EXTENDED POUNDS
80	17	83.0	87.2		405,400*
	18	82.3	87.0		386,000*
	19	81.5	86.9		366,700*
	20	80.8	86.7		349,100*
	22	79.3	86.3		318,300*
	24	77.9	85.8		292,200*
	26	76.4	85.3		270,000*
	28	74.9	84.7		250,600*
	30	73.4	84.1		233,700*
	32	71.9	83.4		218,800*
	34	70.4	82.7		[illegible]
	36	68.8	81.9		183,400
	38	67.3	81.0		169,300
	40	65.7	80.0		157,000
	42	64.1	79.0		146,300
	44	62.4	78.0	116,200	136,900
	46	60.8	76.8	109,300	128,500

Load chart from MANITOWOC 888-II SERIES 2

Jib load charts that contain both strength and stability ratings are called "integrated" charts.

Boom Angle	Jib Offset		
	0°	15°	30°
70°	9,000	6,000	4,400
65°	7,750	5,600	4,150
60°	6,900	5,200	3,950
55°	6,300	4,950	3,800
50°	5,800	4,700	3,700
45°	4,820	4,310	3,600
40°	4,080	4,310	3,600
35°	3,520	3,240	3,130
30°	3,090	2,890	
25°	2,760	2,620	

Ratings ABOVE line based on strength

Ratings BELOW line based on stability

Some manufacturers use a separate chart for jib strength capacity but still use the main boom chart for the stability capacity.

MAXIMUM LATTICE JIB LOAD RATINGS IN POUNDS

	Min. Boom Angle	Jib Length In Feet				
		30	40	50	60	70
0° OFF-SET	75°	14,000	12,500	11,000	9,500	8,000
	70°	11,500	10,000	9,000	8,000	7,000
	65°	9,500	8,000	7,000	6,000	5,400
	60°	8,000	6,000	5,000	4,500	3,800
	55°	6,500	4,500	3,600	3,100	2,600
7½° OFF-SET	75°	12,500	11,000	9,500	8,000	6,500
	70°	11,000	9,000	8,000	7,000	5,800
	65°	9,000	7,000	6,000	5,300	4,700
	60°	7,500	5,500	4,500	4,000	3,300
	55°	6,000	4,000	3,200	2,700	2,300
15° OFF-SET	75°	11,000	9,500	8,000	6,500	5,000
	70°	9,500	8,000	7,000	6,000	4,500
	65°	8,000	6,500	5,500	4,600	3,800
	60°	7,000	5,000	4,200	3,500	2,800
	55°	5,700	3,500	2,800	2,300	2,000

NOTE: Below 55° Boom Angles Lifting With Jib Not Recommended.

With lattice jib in operating position powered boom ratings shall be reduced according to the jib length as shown in pounds.

Deductions apply when lifting from boom point with lattice jib erected. Use ratings in "105 feet" column and apply appropriate deduction. For boom lengths less than 105 feet, use boom angle to determine load rating in "105 feet" column. For boom angles not shown, use rating of next lower boom angle.

Jib Length	30 Ft.	40 Ft.	50 Ft.	60 Ft.	70 Ft.
Boom Deduct	2,000	2,600	3,200	3,800	4,400

Maximum jib load ratings are based on structural competence. Jib load ratings at any radius shall not exceed the powered boom load ratings at the same radius, and shall not exceed maximum jib load ratings shown. For bucket ratings on jib, deduct 20% from maximum jib load ratings. Maximum jib operating radius shall not exceed the operating radius of the powered boom for any given length setting. Use of the outriggers is recommended when boom is equipped with jib.

The lesser of the two values is the crane's maximum rated capacity.